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AGRA Earth & Environmental, Inc.
4137 South 500 West
Salt Lake City, Utah 84123
Tel (801) 266-0720
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June 12, 2000
Job No. 0-817-002956

Capitol Preservation Board
% Cooper/Roberts Architects
700 North 200 West
Salt Lake City, Utah 841114

Attention: Mr. Wally Cooper

Gentlemen

Re: Report
Material Testing Services
Existing Material Conditions
Existing Utah State Capitol Building
350 North Columbus Street (1 East)
Salt Lake City, Utah

1 INTRODUCTION

1.1 GENERAL

This report summarizes the results of material testing related to the planned seismic upgrade of the existing Utah State Capitol building in Salt Lake City, Utah. The general location of the site with respect to major topographic features and existing facilities, as of 1975, is presented on Figure 1, Vicinity Map. A detailed layout of the site showing the existing Capitol building is presented on Figure 2, Site Plan.

Most of the test data contained in this report has been provided to Reaveley Engineers, Inc. over the course of this study.

1.2 OBJECTIVES AND SCOPE

The objectives and scope of our study were planned in discussions between Messrs. Perry Brown and Jerod Johnson of Reaveley Engineers, Inc.; Mr. Wally Cooper of Cooper/Roberts Architects; and Messrs. Bill Gordon and Wade Gilbert of AGRA Earth & Environmental, Inc. (AGRA). A detailed outline of the original objectives and scope of this study was presented in our proposal dated May 31, 2000.
The objectives of our services were to determine the strength of existing building materials, including concrete, concrete reinforcement, and structural steel. Specifically, our scope of services included the following:

Evaluating the strength of the existing concrete by obtaining and testing 13 concrete cores from discrete locations within the dome area and the dome support structure.

2 Conducting in-place concrete strength testing at the core sample locations using the Windsor Probe method.

3 Evaluating the strength and grade of existing steel concrete reinforcement by obtaining and testing a representative sample of the existing reinforcement.

4. Evaluating the strength, grade, and welding characteristics of existing structural steel by obtaining and testing three representative samples from existing structural steel members.

1.3 AUTHORIZATION

Authorization to proceed with the proposed scope of services was provided by Mr. Wally Cooper of Cooper/Roberts Architects.

1.4 PROFESSIONAL STATEMENTS

Supporting data upon which our findings and conclusions are based are presented in subsequent sections of this report. Conclusions regarding material properties and strength are based on the results of laboratory and in-situ material testing.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices followed at this time.

2 PROPOSED CONSTRUCTION

The Capitol building will be structurally upgraded to resist anticipated seismic loads. The level to which the building will be upgraded will depend in part on the existing structural condition of the building. It is our understanding that the existing building was completed in about 1915 and is primarily a reinforced concrete structure with structural steel roof framing. Of primary concern is the strength of the in-place concrete and the material type and tensile strength of in-place structural steel and concrete reinforcing steel.

3 SITE CONDITIONS

3.1 BUILDING

The building is a rectangular, five-level structure with a basement level that daylights to the north. The long axis of the building is oriented east-west and the front of the building faces south. A concrete and structural steel dome extends to a significant height above the center of the building. The dome structure is supported at the east, south, west, and north corners by four reinforced

concrete core structures extending from the foundation level to the roof structure above the fourth above-ground level. These concrete core structures include office and storage spaces on the four above ground levels.

4 MATERIAL TESTING RESULTS

4.1 Concrete Testing

Concrete cores were obtained from the north and west sides of the inner ring of the dome, a concrete roof beam spanning the west end of the building above the House legislative chamber, and from closet spaces within the dome support core structures at each of the four above-ground floor levels. The dome cores were obtained from the same level and locations as cores obtained by others during a previous evaluation of existing concrete strength. A total of 13 concrete cores were obtained and tested for compressive strength and unit weight. A summary of the test results is provided in the attached Table 1.

The results of the laboratory compressive tests indicate that the uncorrected compressive strength of the structural concrete ranges from 900 to 5,262 pounds per square inch. Since several of the tested cores had length-to-diameter (L/D) ratios of less than 2, the compressive strengths were corrected in accordance with procedures outlined in the ASTM C 42M-99 specification. The corrected compressive strengths ranged from 875 to 4,697 pounds per square inch. Although most of the cores had relatively low unit weights, there is no discernable correlation between the unit weight and compressive strength of the cores.

In general, the concrete cores from the dome inner ring had lower compressive strengths than the cores taken from the first through fourth floors. Within the dome area, the exposed concrete exhibited relatively poor workmanship, and varying amounts of small voids and variable distributions of aggregate sizes were observed in the cores. This was particularly evident in portions of the cores corresponding to the outer two to three inches of the in-place concrete. In addition, site observations indicated that the workmanship and placement quality varied between the different concrete lifts forming the inner ring of the dome.

The compressive strengths of concrete cores obtained from the beam and the four above-ground floor levels varied somewhat with general location. The cores obtained from the northeast corners of the dome support structures (Nos. 2 and 3 on Table 1) exhibited slightly lower strengths than those obtained at the beam and the remaining floor level locations.

4.2 Windsor Probe Concrete Testing

Windsor Probe testing was conducted at most of the concrete core locations. Windsor Probe testing was conducted in accordance with the ASTM C 803-90 Standard Test Method for Penetration Resistance of Hardened Concrete. A total of 11 Windsor Probe tests were performed. A summary of the test results is provided in the attached Table 2, along with the laboratory compressive strengths of the corresponding cores.

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Except for the dome area, the Windsor Probe results match closely, in general order of magnitude, the laboratory compressive test results. In the dome area and at the northeast corners of the dome support structures (locations of core Nos. 2 and 3), the strengths determined by the probe testing are generally higher and more consistent than the laboratory strengths. At the remaining core locations, the strengths determined by the probe testing were consistently somewhat lower than the laboratory compressive test results.

4.3 Steel Reinforcement Testing

A sample of concrete reinforcing steel was obtained from a concrete foundation wall in Room B-15 for material typing and tensile testing. The reinforcing sample was about 30 inches long and consisted of a round bar with a nominal diameter of one-half inch. The sample was submitted to American Metallurgical Services, an outside laboratory, for chemical and tensile testing.

The maximum tensile strength of the sample was 72,500 pounds per square inch. The yield tensile strength was 55,500 pounds per square inch. The results of the reinforcing steel testing are included as Attachment 1.

Based on the chemistry data and measured tensile strengths, the reinforcing sample would correspond approximately to a Grade 50 mild or low-alloy steel. It should be noted that the reinforcing steel was produced over 85 years ago, and the current grade classifications are not strictly applicable. We recommend using a maximum yield tensile strength of 50,000 pounds per square inch for the existing reinforcing steel.

4.4 Structural Steel Testing

Three samples of structural steel were obtained and submitted to American Metallurgical Services for chemical testing and material typing. Two of the samples were obtained from roof truss braces above the House and Senate legislative chambers and were also tested for tensile strength. The third sample was a small coupon obtained from the dome roof support system. The results of the chemical analyses and the tensile tests are included as Appendix A. The following table describes the approximate sample locations.

Sample ID[1]	Sample Location
East	Truss brace, west side of Senate chamber roof/ceiling support system
West	Truss brace, west end of House chamber roof/ceiling support system
Corner	Top of Capitol building dome

[1] American Metallurgical Services designation (see Appendix A)

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Based on the test results, all of the above samples meet the chemistry and tensile strength requirements of the ASTM A36 specification. The carbon content of the samples is low to moderate and should not impact welding to similar steels or limit the selection of an appropriate welding process. The maximum tensile strengths for the two tested samples ranged from 64,000 to 65,000 pounds per square inch, and the yield tensile strengths ranged from 41,800 to 42,400 pounds per square inch.

We appreciate the opportunity of providing this service for you. If you have any questions or require additional information, please do not hesitate to contact us.

Respectfully submitted,

AGRA Earth & Environmental, Inc.

J. Wade Gilbert, State of Utah No. 367656
Professional Engineer

Reviewed by:

William J. Gordon, State of Utah No. 146417
Professional Engineer

JWG/WJG:lps

Encl Figure 1, Vicinity Map
Figure 2, Site Plan
Table 1, Results of Compressive Tests of Drilled Cores
Table 2, Results of Windsor Probe Testing
Appendix A, Report of Analysis - American Metallurgical Services

Addressee (3)
c: Mr. Perry Brown (1)
Reaveley Engineers & Associates, Inc
1515 South 1100 East
Salt Lake City, Utah 84105

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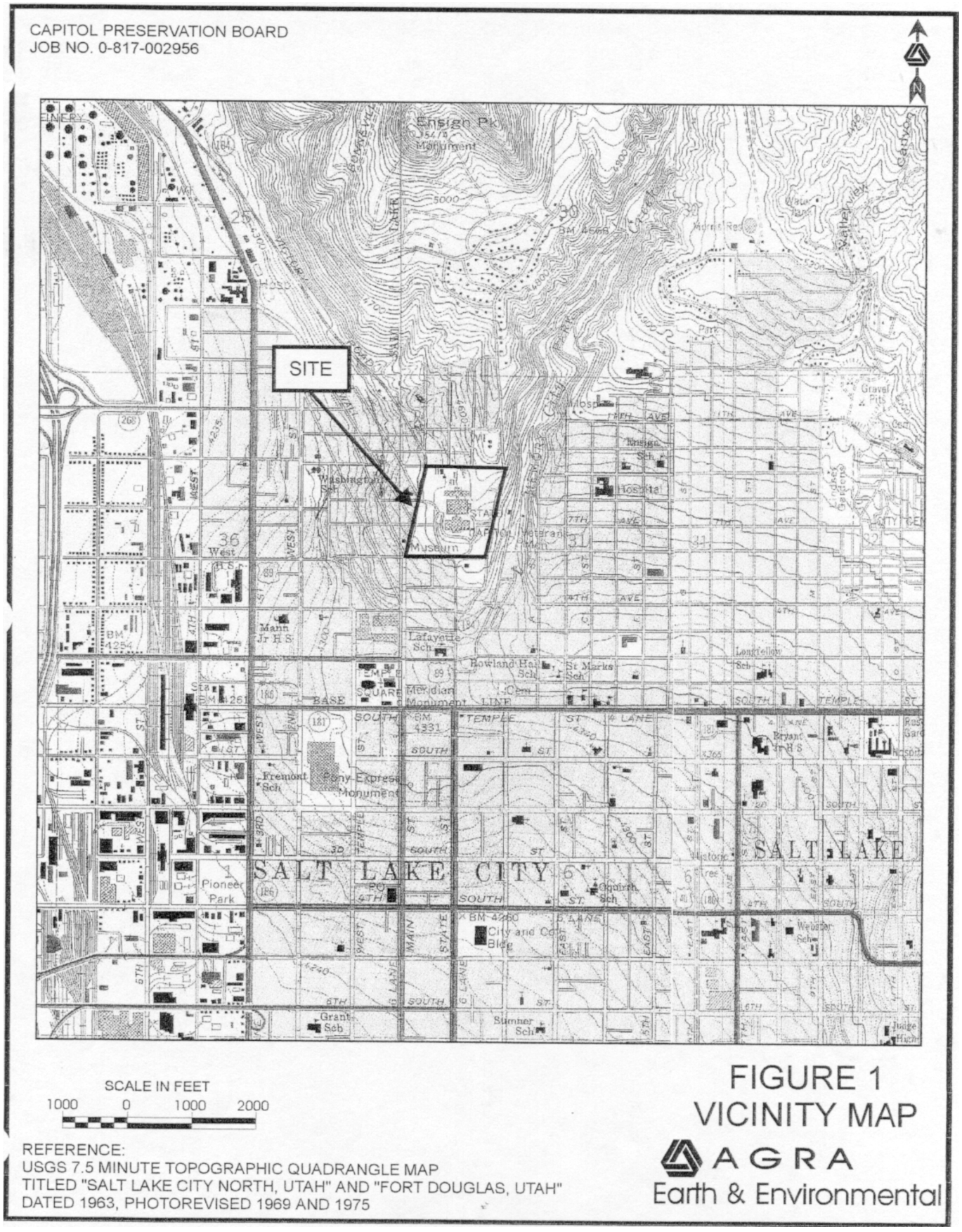
CAPITOL PRESERVATION BOARD
JOB NO. 0-817-002956
SITE
SALT LAKE CITY
SCALE IN FEET
1000 0 1000 2000
REFERENCE:
USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE MAP
TITLED "SALT LAKE CITY NORTH, UTAH" AND "FORT DOUGLAS, UTAH"
DATED 1963, PHOTOREVISED 1969 AND 1975
FIGURE 1
VICINITY MAP
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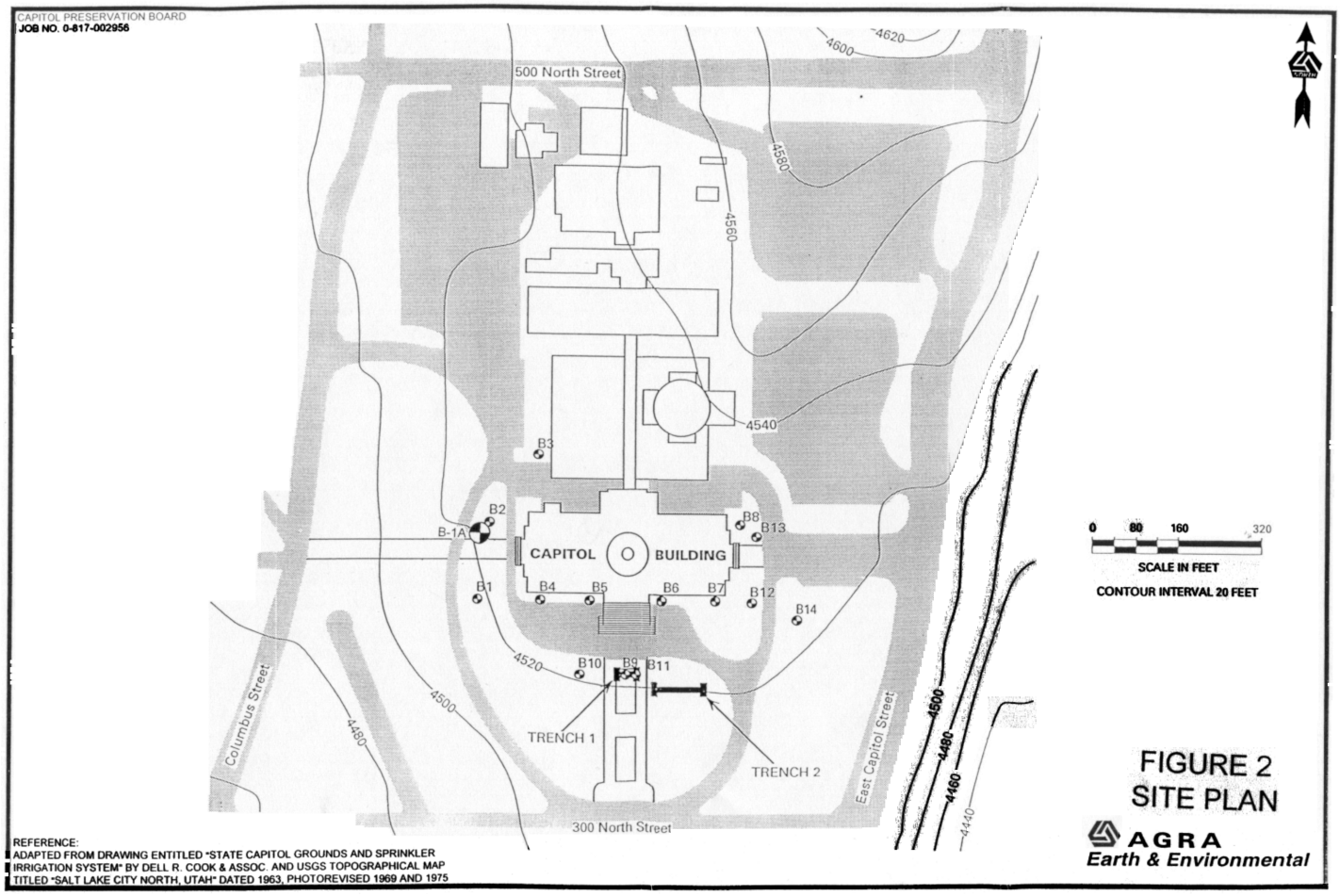
CAPITOL PRESERVATION BOARD
JOB NO. 0-817-002956
500 North Street
4620
4600
4580
4560
4540
4520
4500
4480
4460
4440
B1
B2
B-1A
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
B13
B14
CAPITOL BUILDING
TRENCH 1
TRENCH 2
Columbus Street
East Capitol Street
300 North Street
0 80 160 320
SCALE IN FEET
CONTOUR INTERVAL 20 FEET
REFERENCE:
ADAPTED FROM DRAWING ENTITLED "STATE CAPITOL GROUNDS AND SPRINKLER IRRIGATION SYSTEM" BY DELL R. COOK & ASSOC. AND USGS TOPOGRAPHICAL MAP TITLED "SALT LAKE CITY NORTH, UTAH" DATED 1963, PHOTOREVISED 1969 AND 1975
FIGURE 2
SITE PLAN
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Table 1
RESULTS OF COMPRESSIVE TESTS ON DRILLED CORES

Date: 5/8/2000 AGRA Job No.: 0-817-002956
Client: Capitol Preservation Board
Project Utah State Capitol Building

CORE NO.	CORE LOCATION	LENGTH BEFORE CAPPING (IN.)	VOLUME (FT^3)	WEIGHT (LBS)	UNIT WEIGHT (LBS/FT^3)	LABORATORY COMPRESSIVE STRENGTH (PSI)	CORRECTED[1] COMPRESSIVE STRENGTH (PSI)
1	1st Floor - Southwest Corner	3.513	0.018	2.450	133.2	5,262	4,697
2	2nd Floor - Northeast Corner	5.220	0.027	3.484	129.0	2,271	2,198
3	3rd Floor - Northeast Corner	6.697		4.031		1,856	1,863
4	3rd Floor - Northwest Corner	6.072		4.021			
	4th Floor - Northeast Corner	7.064	0.037				
	4th Floor - Southwest Corner	6.932	0.036	4.672	129.1	3,490	3,523
7	Beam - North	5.070	0.024	3.520	146.6	3,140	3,028
8		6.788		4.650			
		5.374		3.345			
		6.641					
		6.916					
		6.500		4.250	137.1	1,030	1,029

[1] Corrected for ratio of length to diameter (L/D) per ASTM C 42M-99.

COMMENTS

Diameter of all cores was 3.27 inches.

Sampled by: Wade Gilbert/Greene Concrete Coring
Reported by: Steve Madrigal
Reviewed by: Wade Gilbert

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Table 2
RESULTS OF WINDSOR PROBE TESTING

Date: 5/15/2000 AGRA Job No.: 0-817-002956
Client: Capitol Preservation Board
Project State Capitol Building

TEST NO.	TEST LOCATION	WINDSOR PROBE COMPRESSIVE STRENGTH (psi)	LABORATORY COMPRESSIVE STRENGTH (psi)
1	1st Floor - Southwest Corner	3,250	4,697
2	2nd Floor - Northeast Corner	2,475	2,198
3	3rd Floor - Northeast Corner	2,375	1,863
4	3rd Floor - Northwest Corner	2,800	2,463
5	4th Floor - Northeast Corner	2,800	3,085
6	4th Floor - Southwest Corner	2,800	3,523
7	Beam - North	2,475	3,028
7	Beam - South	2,475	2,736
8	Dome North No. 1	1,500	875
9	Dome North No. 2	1,400	1,473
--	Dome West No. 1	--	1,816
10	Dome West No. 2	1,725	2,600
11	Dome West No. 3	2,050	1,029

COMMENTS

One Windsor probe test was conducted between the core sample locations at the beam. Those core samples were approximately one foot apart. A separate Windsor probe test was not conducted at core location No. 1 on the west side of the dome. The laboratory compressive test results are corrected for length to diameter ratio.

Testing by: Steve Madrigal
Reported by Wade Gilbert

S:\WProcessing\Capitol Building Probe and Concrete Test Results.wpd

APPENDIX A

Report of Analysis - American Metallurgical Services

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AMERICAN
METALLURGICAL SERVICES

80 East Claybourne Avenue Salt Lake City, Utah 84115
(801) 484-1777 FAX (801) 484-1782

REPORT OF ANALYSIS

AGRA Earth Enviromental
Attn: Wade Gilbert
4137 South 500 West
Salt Lake City, Utah 84123

May 10, 2000
Project #00-6679

RE: Chemical analysis and tensile test on four samples

CHEMICAL ANALYSIS

Sample #	C	Si	Mn	P	S
East	.18	.047	.52	.026	.050
West	.18	.045	.51	.026	.050
Corner	.15	.035	.35	<.01	.028
Rebar	.22	<.01	.49	.015	.050

The above meet ASTM A36 or equivalent specifications

TENSILE TEST:

Sample #	(PSI) Tensile Strength	(PSI) Yield Strength	% Elong.
East	65,000	41,800	37
West	64,000	42,400	32
Rebar	72,500	55,500	32

The above meet ASTM A36 or equivalent specifications

Clyde L. Larsen, Chief Metallurgist